TECHNICAL REPORT
NATICK/TR-11/013

AD _____

PRODUCE SANITATION SYSTEM EVALUATION

by
John Gildea
Louis Jamieson
and
Josh Magnone

May 2011

Final Report
June 2009 - July 2009

Approved for public release; distribution is unlimited

U.S. Army Natick Soldier Research, Development and Engineering Center
Natick, Massachusetts 01760-5018

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14. ABSTRACT

This report documents an evaluation, performed by the Department of Defense (DoD) Combat Feeding Directorate (CFD), of an automated produce cleansing and sanitizing sink in an effort to facilitate a more effective and efficient means for cleansing and sanitizing fresh fruits and vegetables (FF&V) aboard Navy vessels, The sink saves labor associated with the washing of produce in food service operations by automatically performing this effort, thus allowing food service personnel to perform other tasks while the produce is being washed and sanitized. The system was also expected to improve food safety (i.e., reduce microbes) and reduce premature spoilage while minimizing environmental impact and unpleasant aftertaste through it computer-based cleansing process and use of a citrus-based "green" cleansing product. Microbiologists from CFD performed several tests of bacteria counts and pathogen log rate reductions of various FF&V products before and after they passed through the sanitizing sink process. The tests results show that the sink removes microbes from FF&V more effectively than the current method of hand washing utilized aboard Navy vessels. The integration of the automated produce sink within the Navy will support the Navy's optimized crewing initiative and ensure food safety for the sailors aboard naval vessels. CFD has been recommended by the unit to Navy stakeholders for further evaluation at sea.

15. SUBJECT TERMS

TIME	SENSORS	MANPOWER	RELIABILITY	AUTOMATION	ERROR REDUCTION
COSTS	BACTERIA	SHIPBOARD	FOOD SAFETY	NAVAL VESSELS	WASHERS(CLEANERS)
FRUITS	CLEANING	WORKLOAD	MONITORING	LABOR SAVINGS	NATURAL RESOURCES
WATER	PRECISION	REDUCTION	VEGETABLES	CONTAMINATION	TEST AND EVALUATION
SAFETY	PH FACTOR	SANITATION	FRESH FOODS	MICROORGANISMS	COST BENEFIT ANALYSIS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Louis Jamieson
U	U	U	SAR	32	19b. TELEPHONE NUMBER *(include area code)* (508) 233-4103

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PREFACE

This report documents a performance evaluation of the X-Green Produce Sanitation System conducted by the Department of Defense (DoD) Combat Feeding Directorate (CFD), Systems Equipment and Engineering Team (SEET). This system, produced by SteelKor, was designed to clean and sanitize fresh fruits and vegetables (FF&V) automatically to provide an efficient and user-friendly unit. This evaluation was preformed from 24 June through 28 July 2009, under Project Number GS-07F-0103J, as part of an effort to allow for more effective and efficient sanitizing of FF&V on board Navy vessels. The evaluation included microbiological testing to determine the system's effectiveness in reducing bacteria and microorganisms (microbes). By reviewing the features and systematically testing the unit, the SEET was able to determine the overall labor savings, reduction in microbes and bacteria, as well as the usability of the unit.

PRODUCE SANITATION SYSTEM EVALUATION

1. INTRODUCTION

To allow for more effective and efficient sanitizing of fresh fruits and vegetables (FF&V) on board Navy vessels, the Department of Defense (DoD) Combat Feeding Directorate (CFD), Systems Equipment and Engineering Team (SEET) conducted a performance evaluation of the X-Green Produce Sanitation System produced by SteelKor, LLC, from 24 June to 28 July 2009.

The X-Green system (Figure 1) was evaluated for its potential to reduce the overall time to wash produce and to increase the microbial safety of FF&V in accordance with the requirements of recently passed legislation, including The Food Safety Enhancement Act of 2009. Currently, the crew preparing produce have to hand wash all produce, taking up valuable time that could be used elsewhere in the galley. Furthermore, NAVMED P5010-1 requires that produce that is purchased overseas be sanitized in a 100 ppm chlorine solution. Chlorine is a hazardous chemical and if not measured correctly is either not effective or leaves an unpleasant taste in the food. The X-Green uses a citrus-based green product that is completely safe and leaves no aftertaste. The X-Green also eliminates errors in chemical measurements because the computer maintains proper pH levels based on input from an onboard sensor.

The SteelKor. X-Green Produce Sink (Figure 1) is a versatile and relatively new product that is capable of eliminating microbes and bacteria that cause food-borne illnesses. The unit was designed and built by SteelKor, LLC for use in a commercial environment to clean produce better than hand washing. The power requirements are 220 Vac, 60 Hz, single phase. The major components are refrigeration, agitation, and chemical injection systems that are all automated and controlled by a touch screen interface.

Figure 1: SteelKor, LLC. X-Green Produce Sanitation System

The X-Green uses two products to provide safe and effective cleaning of FF&V: (1) the FIT® Vegetable Wash and (2) the HealthPro Brands, Inc. defoamer. FIT® is made from all-natural ingredients such as citric acid and grapefruit oil. FIT® is also certified kosher and certified vegan. The material safety data sheet (MSDS) for FIT® can be found in Appendix A. The defoaming agent is a food grade silicone solution that is injected in small quantities to minimize foaming. The defoamer MSDS can be found in Appendix B. Due to the nature of FIT®, a small amount of defoamer is injected to prevent excessive foaming. Figure 2 shows the FIT® and defoamer chemical injection system. For every cycle that is run, data including the time and date, pH, temperature, and soak time are collected. The data are stored internally and can be recalled, as well as printed out, after each cycle using an onboard label printer. Figure 3 shows the control panel layout of the printer.

Figure 2: FIT® and Defoamer Injection System

Figure 3: X-Green Control Panel and Label Printer

2. INSTRUMENTATION AND MATERIALS

2.1 System Verification Testing

Upon receipt of the X-Green Produce Sink from SteelKor, the unit was immediately tested to ensure proper functionality, using the instruments listed in Table 1. A multi-logger thermometer was used to qualify the temperature readings given by the X-Green and ensure the system was within the set range during the FF&V washing. Type-K (24-gauge) thermocouples were used in conjunction with the thermometer. The thermometer was held in the center of the sink while the agitation pump was running to ensure the water temperature was the same throughout.

Table 1: Test Instruments

Instrument	Model Number
Omega multi-logger thermometer	HH506RA
Thermocouples, 24-gauge	Type –K

2.2 Reprogramming of the X-Green System

Initial testing of five* FF&V products using the X-Green Produce Sink at the factory default temperature of 49 °F showed that the chilled FIT® solution did not provide the expected microbe reductions. SteelKor was contacted, and the system was reprogrammed to disable the refrigeration unit and allow testing to be done with ~ 70 °F tap water.

2.3 FF&V Tested

The FF&V used for testing were supplied by SYSCO and were packaged in cases by individual product, one case for each test. Table 2 lists the six products provided for testing and the amount in each product's case.

Table 2: Produce Packaging

Product	Amount
Tomatoes	25 lb
Broccoli	20 lb
Iceberg lettuce	6 heads
Romaine lettuce	10 lb
Potatoes	50 lb
Pears	200 count

* Pears were not available for this test. The six products listed in Table 2 were provided for all the other tests.

3. FF&V TESTING AND ANALYSIS METHODOLOGY

Four washing tests were performed in order to evaluate and maximize the effectiveness of the X-Green produce sanitation system in cleaning and sanitizing FF&V. One case of each product was used in each test except the tests described in Sections 3.2 and 3.4, in which only five and four of the items, respectively, were tested. Before any products were washed, samples from each case were tested for bacteria and microbes to determine the starting contamination of the FF&V before washing. Different samples were removed from the same cases and washed. After each different wash procedure, samples were taken and tested for bacteria and microbes to determine the log reduction for each wash procedure.

The first test was hand washing as a baseline for evaluating the performance of the X-Green system. Next, three different wash tests were performed using the X-Green. In each test, the sink compartment was filled to the capacity of 35 gal of water, and the pH was set to 3.7. The X-Green system was loaded with samples from a case of a single product, as shown in the tomato example in Figure 4, and was allowed to run through the specified soak cycle for that product. The soak cycle times, listed in Table 3, were varied by product. The X-Green's computer maintained proper temperature, pH level, and soak times automatically for all trials. In the first X-Green test, the water temperature for each product was set at the factory default temperature of 49 °F. In the next test, the refrigeration unit was turned off, and the system was filled with ~ 70 °F tap water. This test was repeated on the four leafy green and rooted type FF&V (i.e., broccoli, iceberg lettuce, romaine lettuce, and potatoes) to assess the effect of double soaking time. When this third X-Green wash test was completed, the equipment was tilt tested to determine whether it could meet the Naval vessel requirement of remaining operable when inclined to 15° in any direction.

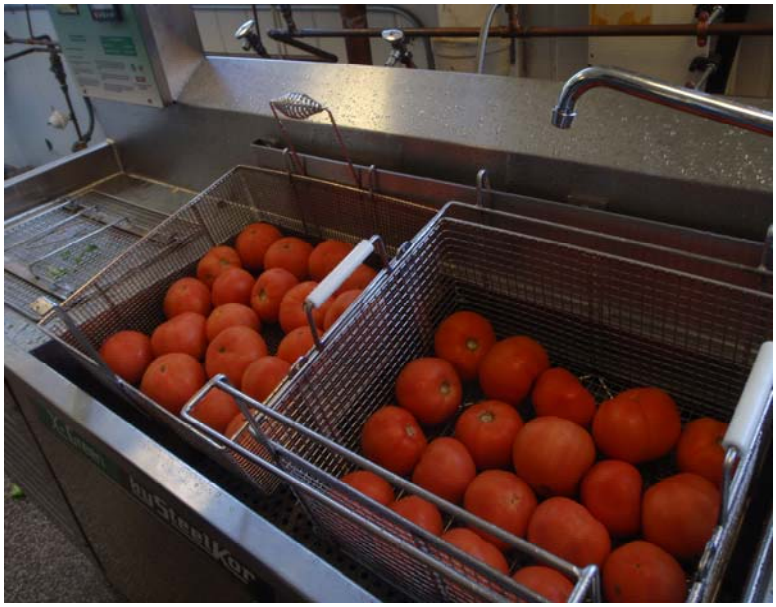


Figure 4: Loading One Case of Tomatoes

Table 3: X-Green Soak Cycle Times

Item	Min
Tomatoes	2
Broccoli	3
Iceberg lettuce	3
Romaine lettuce	3
Potatoes	8
*Pears	2

*Pears were not available for testing in the X-Green at the default temperature of 49 °F.

3.1 Hand Washing of FF&V

This test was done to get a baseline for the labor intensiveness and effectiveness of traditional hand washing of FF&V items to compare against the speed and effectiveness of the X-Green. Samples of each of the six FF&V products were washed according to NAVMED P5010-1, with no detergent under a continuously running standard faucet providing ~ 70 °F water at a rate of 2 gal/min until all visible soils were removed. The time required to thoroughly wash each product was recorded and compared with the X-Green cycle time for that product. The washed samples were tested for microbes for comparison with the untreated samples and the samples washed in the X-Green.

3.2 X-Green System at 49 °F

The X-Green was set to the factory default of 49 °F and 3.7 pH. Cycles were run on a new case of five of the six products (all but the pears) based on product description, as listed in Table 3. Pears were not available for this test. The washed samples were tested for microbes.

3.3 X-Green System at 70 °F

When results from testing following washing with chilled FIT® solution did not provide the expected microbe reductions, SteelKor disabled the refrigeration unit, and the test was repeated on another case of each of the six products using tap water at ~ 70 °F at the same pH with the same soak times. The objectives were to determine the effectiveness of the FIT® solution in warmer water and to determine whether the expense of using refrigeration could be eliminated. The washed samples were tested for microbes.

3.4 X-Green System at 70 °F and Double Cycle Time

After the results from the testing following washing with ~ 70 °F FIT® solution were obtained, an additional (double cycle) test was repeated on a new case of each of the four leafy green and rooted type FF&V (i.e., broccoli, iceberg lettuce, romaine lettuce, and potatoes) to see if a second cycle would be more effective at reducing bacteria and microbes in those products, as their levels were much higher than those for the tomatoes and pears. As in the other tests,

samples were removed from the new cases and tested for microbes without washing. Other samples from the same cases were then washed twice (two of the standard cycles listed in Table 3) in the X-Green. The washed samples were tested again for microbes.

3.5 Tilt Testing

To be allowed on board a ship, food service equipment must meet the Naval vessel requirement of remaining operable when inclined to 15° in any direction. The X-Green was tilted 15° from the front, back, left, and right sides and held for 4 min in each direction. The water levels were monitored for overflow, and the overall operation was checked while the sink was tilted. Figures 5 and 6 show the unit at a 15° angle tilted from the left side and back side, respectively.

Figure 5: Unit Tilted 15° from Its Left Side

Figure 6: Unit Tilted 15° from Its Back Side

4. RESULTS AND DISCUSSION

4.1 Hand Washing of FF&V

Each FF&V case was hand washed according to NAVMED P5010-1, removing all visible soil and contaminants. Figure 7 compares the amount of time it took to wash a case of each product by hand and in the X-Green system. The X-Green cycle times were significantly shorter than the hand-wash times for each item, ranging from a reduction of ~ 20 % for iceberg lettuce to > 80 % for potatoes. Though these reductions do not necessarily translate to the same levels of labor reduction because of other tasks associated with the X-Green and the possible need for extended cycles with some products (discussed in Section 4.4), they do represent potential to significantly reduce the amount of labor spent on cleaning FF&V. Refer to Table 2 for case sizing.

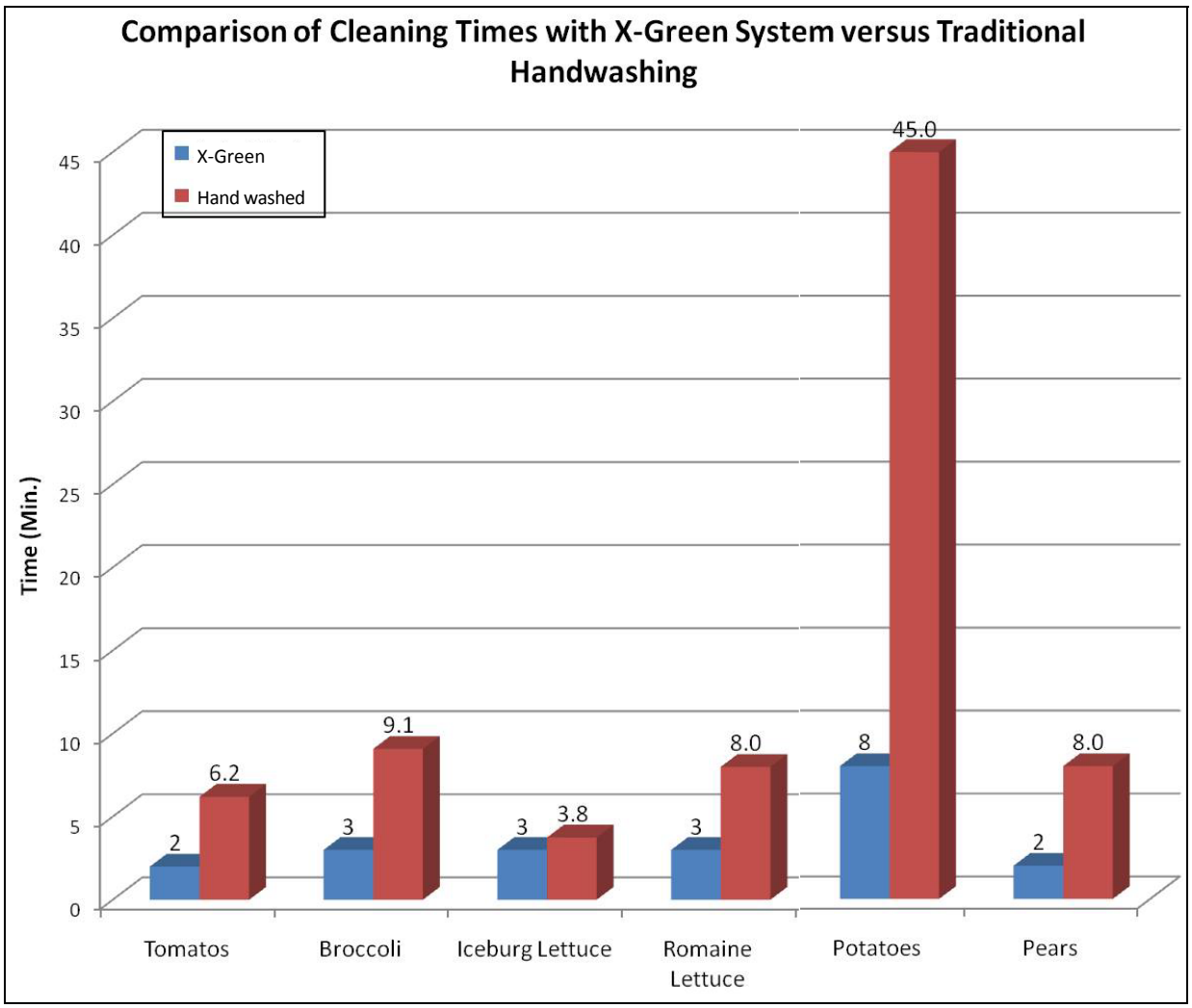
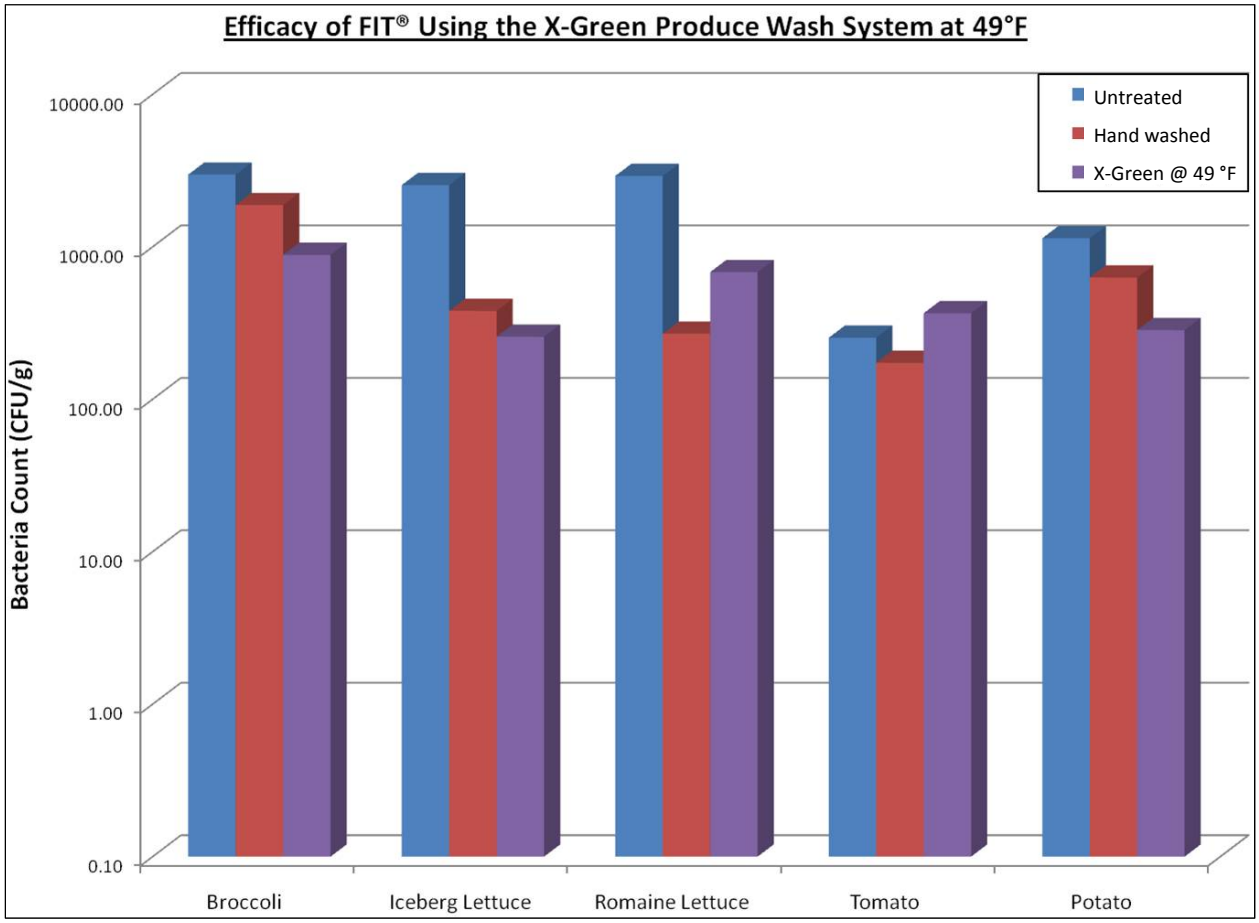


Figure 7: Wash Time Comparison: Hand Wash and X-Green

The microbe testing of untreated FF&V items revealed that the produce had very low microbial counts to begin with. Testing for microbes following the traditional hand washing, under a standard faucet with the water flowing at 2 gal/min at ~ 70 °F showed an average of 0.50 log reduction in microbes on the FF&V products. The microbe levels for untreated and hand-washed samples except for pears are shown in Figure 8. These levels are repeated with the levels for the pears included in Figure 9 for comparison with a different X-Green wash test.

4.2 X-Green System at 49 °F

Using the X-Green set at the factory default temperature of 49 °F and pH of 3.7 resulted in an average of 0.52 log reductions compared with the untreated samples. The broccoli, iceberg lettuce, and potatoes had slightly lower microbe counts after washing in the X-Green compared with the hand-washed samples, but the romaine lettuce and tomato produced slightly better results with hand washing. This is likely due to the difference in water temperature between the X-Green (49 °F) and the tap water (70 °F). Figure 8 compares the microbe counts of the untreated, hand-washed, and 49 °F X-Green-washed products.



Pears were not available for testing in the X-Green at the default temperature of 49 °F.

Figure 8: Microbe Count Comparison: Untreated, Hand Washed @ 70 °F, and X-Green @ 49 °F

4.3 X-Green System at 70 °F

Disabling the refrigeration capability of the X-Green and filling it with ~ 70 °F tap water provided favorable results. The average log reduction of microbes compared with the hand-washed samples was 1.31, much higher than the previous test using the FIT® solution at 49 °F. As shown in Figure 9, each of the six FF&V products tested at 70 °F showed a significant log reduction in microbes compared to both untreated and hand-washed produce. As shown in Figure 10, each of the five FF&V products tested at 49 °F showed a log reduction in microbes when tested at 70 °F, with a dramatic reduction in the tomatoes.

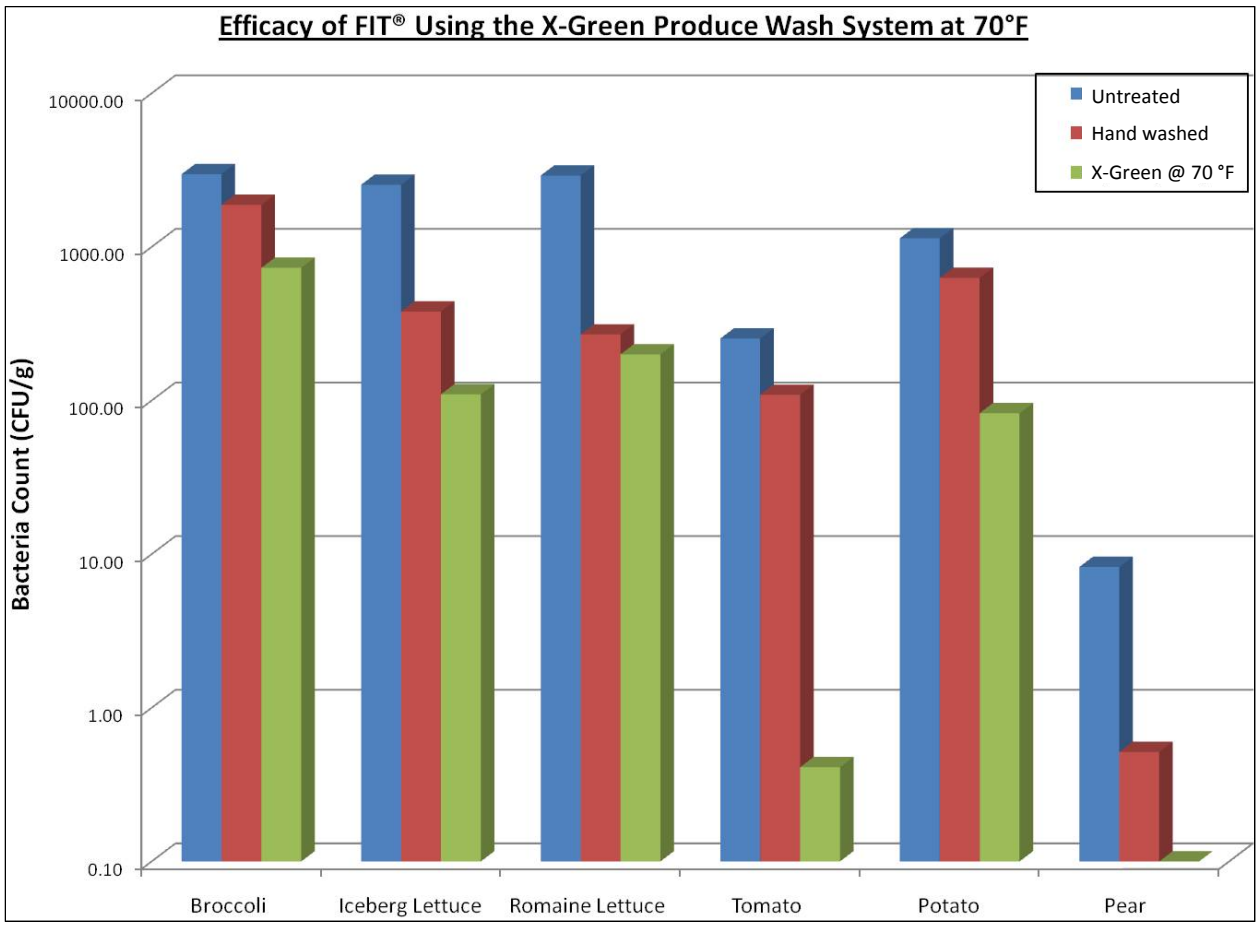
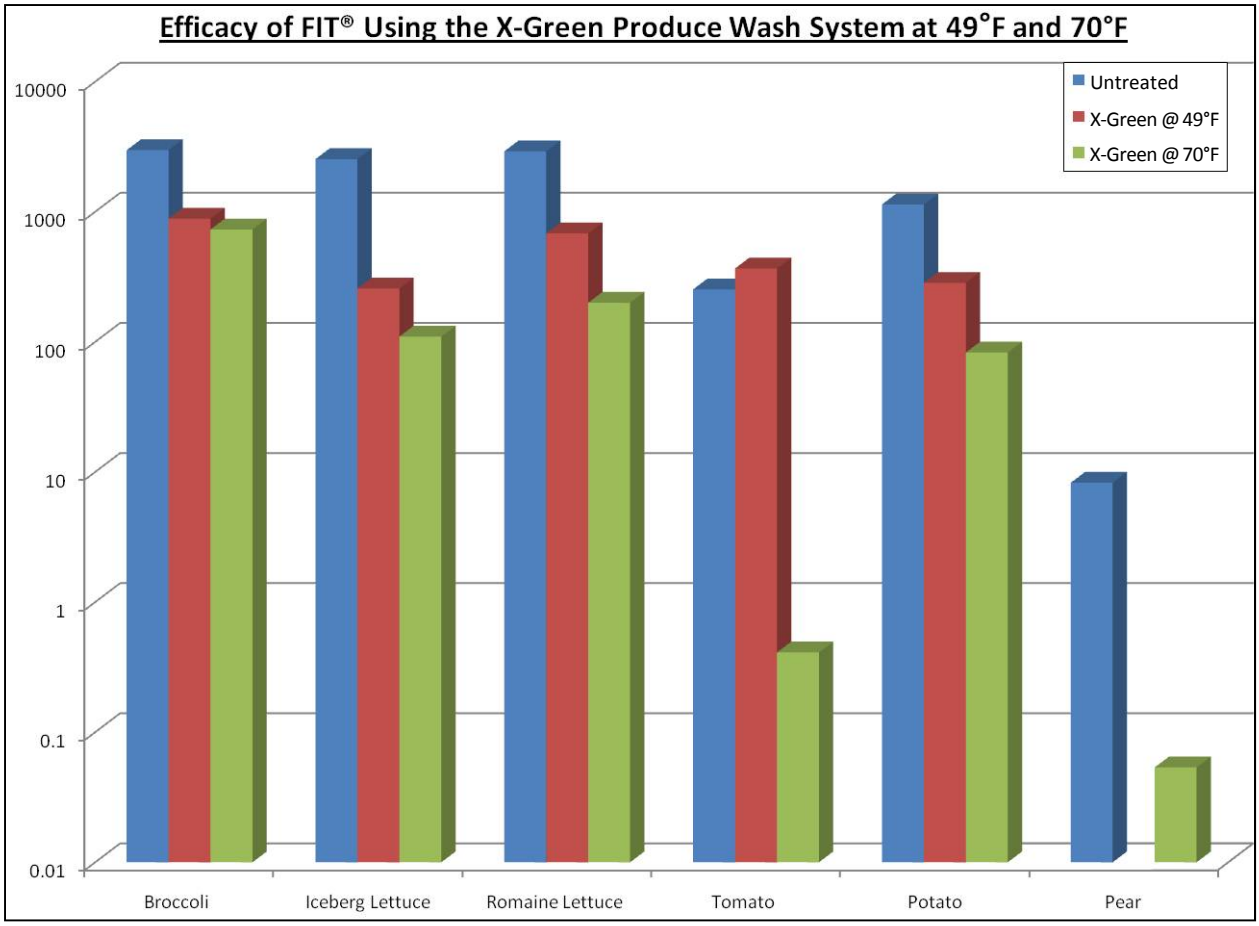


Figure 9: Microbe Count Comparison: Untreated, Hand Washed @ 70 °F, and X-Green @ 70 °F

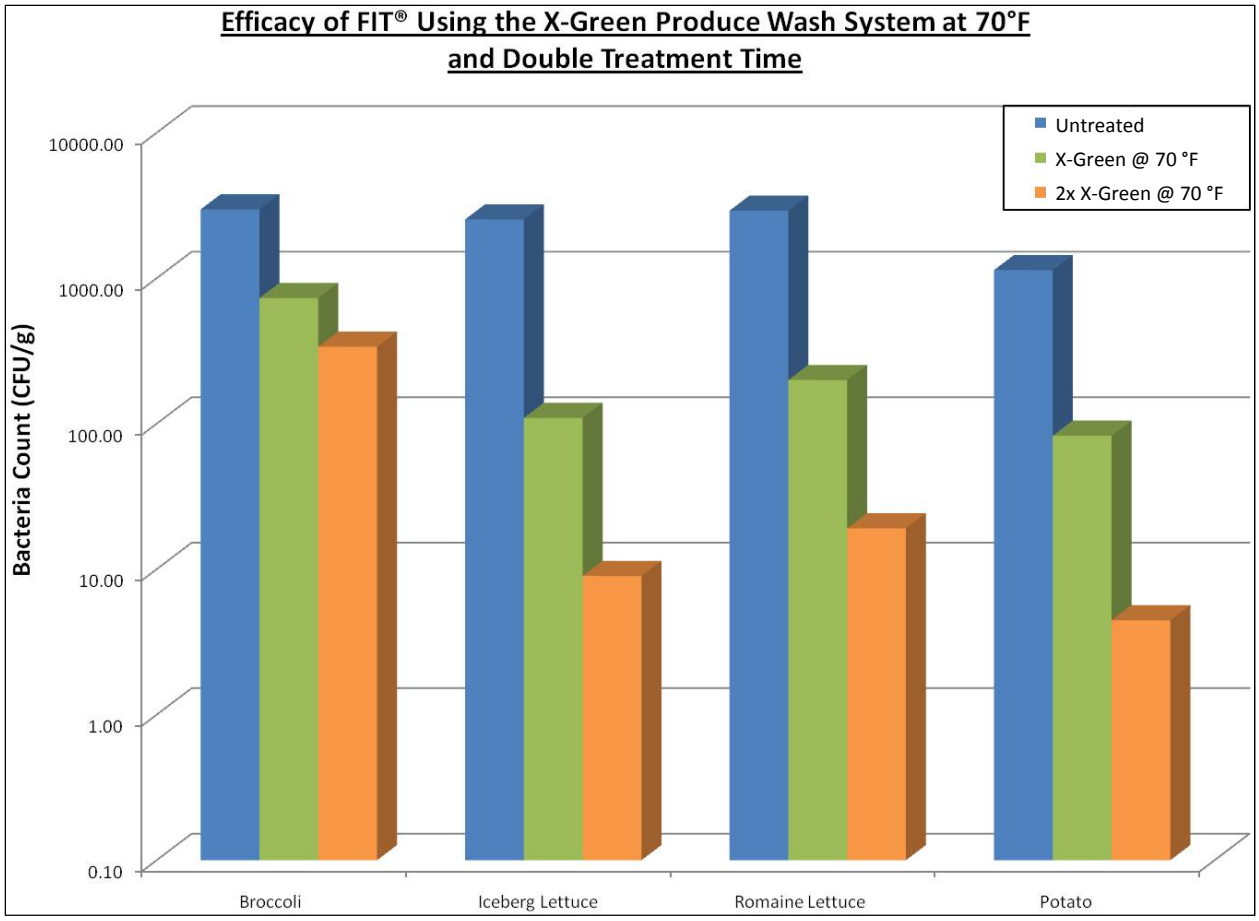


Pears were not available for testing in the X-Green at the default temperature of 49 °F.

Figure 10: Microbe Count Comparison: Untreated, X-Green @ 49 °F, and X-Green @ 70 °F

4.4 X-Green System at 70 °F and Double Cycle Time

The final test of the X-Green was to determine if lengthening the soak cycles would produce results that were any better than the default cycle lengths. The leafy green and rooted type FF&V (i.e., broccoli, iceberg lettuce, romaine lettuce, and potatoes) were given a second soak cycle in the X-Green with the FIT® solution at ~ 70 °F. The tomatoes and pears were not included in this test because they had lower microbe counts than the others from the start. The results show there was in fact a further reduction using double soak times compared with the default soak times, though the levels for each product were still higher than for both the tomatoes and the pears following the default soaking. The microbe levels of these four products before any washing and after both the first second cycles in the X-Green with ~ 70 °F FIT® solution are compared in Figure 11.



Tomatoes and pears were not chosen for double cycle testing.

Figure 11: Microbe Count Comparison: Untreated, X-Green @ 70 °F, and X-Green @ 70 °F Double Cycle

4.5 Tilt Testing

The unit was tilted 15° in each direction and held for up to 4 min, and operated continuously while it was tilted. The water levels were monitored. No water overflowed onto the floor or into the sink drain. The unit's performance was not affected by operating on an uneven surface.

5. CONCLUSIONS AND RECOMMENDATIONS

By automating the FF&V cleaning and sanitizing procedure, the SteelKor, LLC. X-Green Produce Sanitation System has the ability to significantly reduce the amount of labor spent on washing FF&V. Furthermore, the test results indicate that the X-Green, when used with tap water (~70 °F) can remove microbes and bacteria from FF&V more effectively than the current method of hand washing. However, at the default water temperature setting of 49 °F, the X-Green yielded results that were less favorable for some products and only marginally better for others than the results of hand washing in tap water (70 °F). Doubling the soak times yielded produce that was visibly cleaner with lower microbe levels than the default soak times. The unit is capable of operating at a 15° angle in any direction, proving that it can operate shipboard. Testing proves that the X-Green has the capability of reducing the amount of labor needed for FF&V preparation and increasing food safety.

This equipment asset saves time, increases food safety, reduces costs, and provides an ergonomic design application of human systems integration principles. In addition, the use of this innovative technology supports the Navy's optimized crewing plan. Not only does the X-Green save labor, but it also maximizes performance effectiveness when washing and sanitizing FF&V overseas.

Based on these initial test results, the SEET recommends the SteelKor, LLC. X-Green Produce Sanitation System. The unit used for initial testing had a refrigeration unit built-in, but a version of this unit is manufactured without the refrigeration. The testing indicates that the FIT® solution is more effective in 70 °F water, making refrigeration unnecessary. Omitting refrigeration will reduce initial costs and maintenance costs and will increase the effectiveness of sanitizing FF&V. SEET also recommends that the soak times for rooted and leafy green FF&V be doubled to provide the most effective sanitization. CFD recommends that this unit undergo a 6-month at-sea user evaluation coordinated through the Naval Sea Warfare Center Carderock Division, Habitability (Code NAVSEA 05) to complete required operational evaluations.

This document reports research undertaken at the U.S. Army Natick Soldier Research, Development and Engineering Center, Natick, MA, and has been assigned No. NATICK/TR- 11/013 in a series of reports approved for publication.

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APPENDIX A
FIT® MATERIAL SAFETY DATA SHEET

(Reprint of original)

Material Safety Data Sheet

03-OCT-2006

Fit Antibacterial Fruit & Vegetable Wash

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

PRODUCT NAME: Fit Antibacterial Fruit & Vegetable Wash
PRODUCT USE: Fruit & Vegetable Wash

Company Identification

MANUFACTURER/DISTRIBUTOR

HealthPro Brands, Inc.
11400 Grooms Road, Suite A
Cincinnati, OH 45242

PHONE NUMBER

Emergency/ Product Information: 1-800-354-9709

HAZARDS IDENTIFICATION

**********EMERGENCY OVERVIEW**********
* Clear, slightly yellow liquid. Irritating to skin and eyes. *
****

Potential Health Effects:

EYE: Contact will cause irritation.

SKIN: Contact can cause irritation.

INGESTION: May cause irritation to gastrointestinal tract.

INHALATION: None.

CHRONIC (CANCER) INFORMATION: None known.

LONG TERM TOXIC EFFECTS: None known.

COMPOSITION/INFORMATION ON INGREDIENTS

Source: HealthPro Brands, Inc.

Material	CAS Number
WATER	7732-18-5
CITRIC ACID	77-92-9
ETHANOL	64-17-5
GRAPEFRUIT OIL TERPENES	68917-32-8
SODIUM LAURYL SULFATE	151-21-3

FIRST AID MEASURES

First Aid

INHALATION: None.

SKIN CONTACT: Remove and wash contaminated clothing. Wipe off and wash with soap and water.

EYE CONTACT: Irrigate eyes with running water for at least 15 minutes. Get medical attention if irritation develops.

INGESTION: Rinse mouth with water. Dilute with water. Get medical attention if discomfort occurs.

FIRE FIGHTING MEASURES

FLASH POINT F° (C°): Not flammable.
EXTINGUISHING MEDIA: Water, carbon dioxide, powder, foam

SPECIAL FIRE FIGHTING PROCEDURES / UNUSUAL FIRE OR EXPLOSION HAZARDS:

Firefighters should use equipment as required for surrounding fire.

ACCIDENTAL RELEASE MEASURES

Mop up. Rinse with water.

HANDLING AND STORAGE

STORAGE TEMPERATURE: Ambient.
HANDLING & STORING: Store in closed packages.

EXPOSURE CONTROLS/PERSONAL PROTECTION

EYE PROTECTION REQUIREMENTS:.... ...Goggles for handling large quantities of pure material.
SKIN PROTECTION REQUIREMENTS: .. ...Rubber gloves for handling large quantities of pure material.
RESPIRATOR REQUIREMENTS: ....None.
VENTILATION REQUIREMENTS: ....None.

Exposure Guidelines
None

Source: HealthPro Brands, Inc.

PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE:	Clear, slightly yellowish liquid.
ODOR:	Citrus.

STABILITY AND REACTIVITY

STABILITY:	This is a stable material.
CONDITIONS TO AVOID	Heat or storage below freezing.
HAZARDOUS POLYMERIZATION:	Will not occur.
INCOMPATIBILITIES:	None special.

TOXICOLOGICAL INFORMATION

Mixture untested but based on components:
Eye contact will cause irritation. Can be irritating to skin. Ingestion may cause irritation to gastrointestinal tract.

CARCINOGENICITY: None listed.

ECOLOGICAL INFORMATION

No data.

DISPOSAL CONSIDERATIONS

Waste Disposal:
Treatment, storage, transportation, and disposal must be in accordance with applicable Federal, State/Provincial, and Local regulations.

TRANSPORTATION INFORMATION

DOT – not regulated.

REGULATORY INFORMATION

U.S. Federal Regulations

TSCA Inventory Status: Reported/included.

Section 313 Supplier Notifications.
This product contains no toxic chemicals subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and of 40 CFR 372.

OTHER INFORMATION

Source: HealthPro Brands, Inc.

Additional Information
NA = Not Applicable
NE = Not Established
# = Indicates updated section

NPCA-HMIS Rating
Health : 1
Flammability : 0
Reactivity : 0
Personal Protection rating to be supplied by user depending on use conditions.

STATE RIGHT-TO-KNOW LAWS

No substances on the state hazardous substances list, for the states indicated below, are used in the manufacture of products on this Material Safety Data Sheet, with the exceptions indicated. While we do not specifically analyze these products, or the raw materials used in their manufacture, for substances on various state hazardous substances lists, to the best of our knowledge the products on this Material Safety Data Sheet contain no such substances except for those specifically listed below:

WARNING: SUBSTANCES KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER: None known.

WARNING: SUBSTANCES KNOWN TO THE STATE OF CALIFORNIA TO CAUSE BIRTH DEFECTS OR OTHER REPRODUCTIVE HARM: None known.

This information relates to the specific material designated and may not be valid for such material used in combination with any other materials or in any process. Such information is to the best of our knowledge and belief accurate and reliable as of the data compiled. However, no representation, warranty, or guarantee is made as to its accuracy, reliability or completeness. It is the user's responsibility to satisfy himself as to the suitability and completeness of such information for his own particular use. We do not accept liability for any loss or damage that may occur form the use of this information.

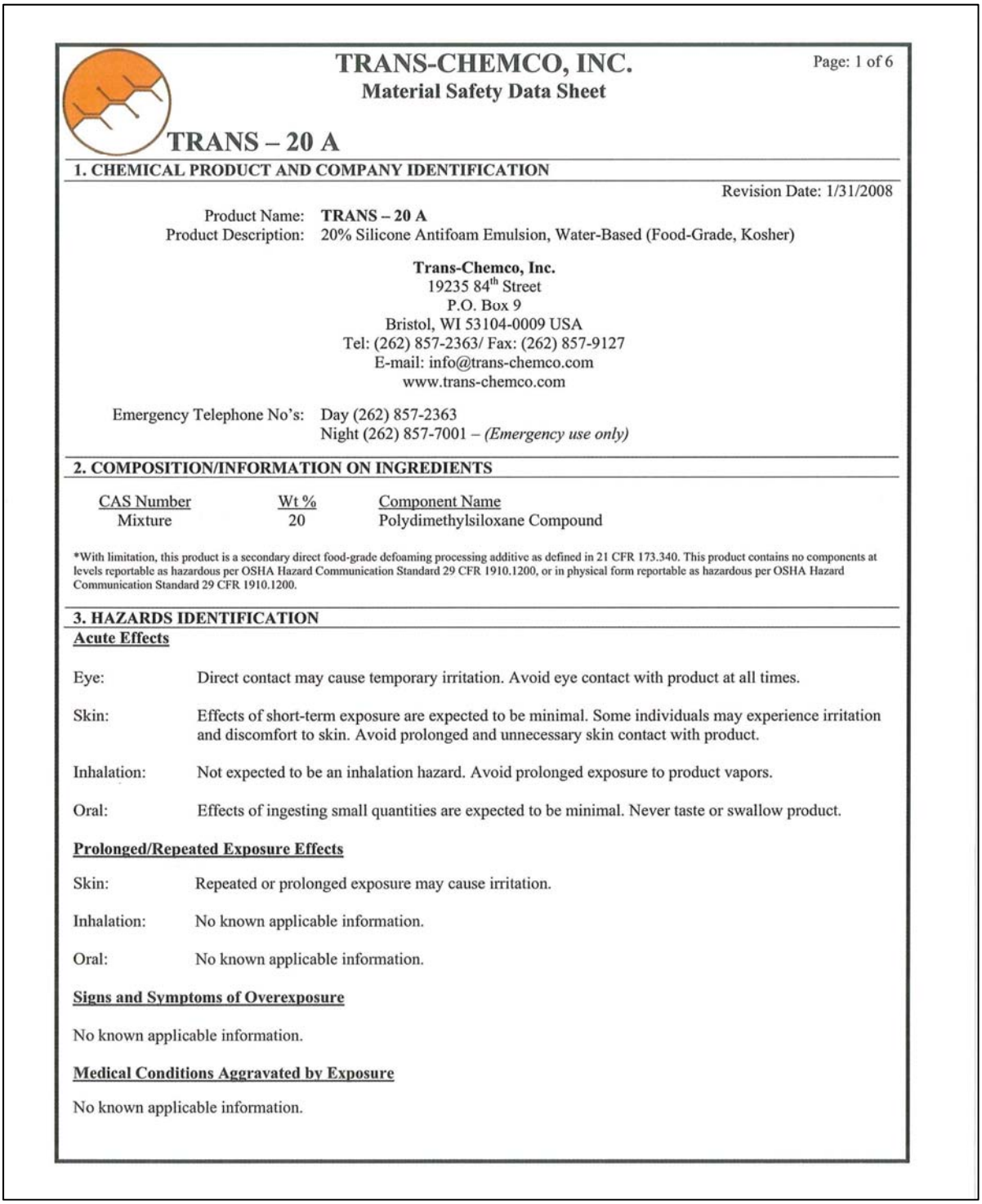
Responsibility for MSDS :

HealthPro Brands, Inc.
11400 Grooms Road, Suite A
Cincinnati, OH 45242

Source: HealthPro Brands, Inc.

APPENDIX B
DEFOAMER MATERIAL SAFETY DATA SHEET

(Reprint of original)



TRANS-CHEMCO, INC.
Material Safety Data Sheet

TRANS – 20 A

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Revision Date: 1/31/2008

Product Name: **TRANS – 20 A**
Product Description: 20% Silicone Antifoam Emulsion, Water-Based (Food-Grade, Kosher)

Trans-Chemco, Inc.
19235 84th Street
P.O. Box 9
Bristol, WI 53104-0009 USA
Tel: (262) 857-2363/ Fax: (262) 857-9127
E-mail: info@trans-chemco.com
www.trans-chemco.com

Emergency Telephone No's: Day (262) 857-2363
Night (262) 857-7001 – *(Emergency use only)*

2. COMPOSITION/INFORMATION ON INGREDIENTS

CAS Number	Wt %	Component Name
Mixture	20	Polydimethylsiloxane Compound

*With limitation, this product is a secondary direct food-grade defoaming processing additive as defined in 21 CFR 173.340. This product contains no components at levels reportable as hazardous per OSHA Hazard Communication Standard 29 CFR 1910.1200, or in physical form reportable as hazardous per OSHA Hazard Communication Standard 29 CFR 1910.1200.

3. HAZARDS IDENTIFICATION

Acute Effects

Eye: Direct contact may cause temporary irritation. Avoid eye contact with product at all times.

Skin: Effects of short-term exposure are expected to be minimal. Some individuals may experience irritation and discomfort to skin. Avoid prolonged and unnecessary skin contact with product.

Inhalation: Not expected to be an inhalation hazard. Avoid prolonged exposure to product vapors.

Oral: Effects of ingesting small quantities are expected to be minimal. Never taste or swallow product.

Prolonged/Repeated Exposure Effects

Skin: Repeated or prolonged exposure may cause irritation.

Inhalation: No known applicable information.

Oral: No known applicable information.

Signs and Symptoms of Overexposure

No known applicable information.

Medical Conditions Aggravated by Exposure

No known applicable information.

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4. FIRST AID MEASURES

Eye:	Immediately flush eyes with a direct stream of water for at least 15 minutes while forcibly holding eyelids apart to ensure complete irrigation of all eye and lid tissue. Get prompt medical attention if irritation develops.
Skin:	Flush skin with water and wash with mild soap and water. Seek medical attention if irritation develops or rash occurs. Remove contaminated clothing and wash before reuse.
Inhalation:	No first aid should be needed.
Oral:	No first aid should be needed. Seek medical attention if large quantities are consumed. Do not induce vomiting except by physician's order. If spontaneous vomiting is inevitable, prevent aspiration by keeping victim's head below the knees.
Comments:	Treat according to person's condition and specifics of exposure.

5. FIRE FIGHTING MEASURES

Flash Point:	> 212 °F / > 100 °C
Auto ignition Temperature:	Not determined
Flammability Limits in Air:	Not determined
Extinguishing Media:	Dry chemical, carbon dioxide, and foam.
Fire Fighting Measures:	Use water spray to cool containers exposed to flames. Do not enter enclosed or confined workspaces without proper protective equipment. Fire fighting personnel should wear respiratory protection (positive pressure if available). If leak or spill has not ignited, use water spray to disperse the vapors.
Unusual Fire Hazards:	None known.

Hazardous Decomposition Products

Thermal breakdown of this product during fire or very high heat conditions may evolve the following hazardous decomposition products: carbon oxides and traces of incompletely burned carbon compounds, silicon dioxide, nitrogen oxides, formaldehyde, and metal oxides.

6. ACCIDENTAL RELEASE MEASURES

Containment /Clean up:	Build dike to contain flow. Remove free liquid. Contain spill and keep from entering waterways or sewers. Use personal protective equipment. Absorb on inert material. Shovel, sweep, or vacuum spill and place in closed container for disposal according to local, state, and federal regulations.

Note: See section 8 for Personal Protective Equipment for Spills. Call Trans-Chemco, Inc. at (262) 857-2363, if additional information is required.

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7. HANDLING AND STORAGE

Storage Conditions:	Store this product below 110 °F (43 °C) in a cool, dry, well-ventilated area away from direct sources of heat, moisture, or sunlight. Do not store near strong oxidizing materials. Preferentially store below 77 °F (25 °C). To prolong shelf life, this product may be refrigerated. Protect product from freezing.
General Precautions:	Keep container tightly closed when handling or storing. Do not dilute product with water and store in diluted form. Exercise good personal and industrial hygiene when handling food-grade antifoams and defoamers. Avoid unsanitary conditions, usage, and storage.

8. EXPOSURE CONTROLS AND PERSONAL PROTECTION

Component Exposure Limits

There are no components at reportable levels with workspace exposure limits.

Engineering Controls

Local Ventilation:	None should be needed.
General Ventilation:	Recommended.

Personal Protective Equipment for Routine Handling and Spills

Eyes:	Always wear eye protection. Goggles or safety glasses with side shields are recommended.
Skin:	Washing at mealtime and end of shift is adequate.
Suitable Gloves:	Neoprene rubber or other chemical resistant material such as nitrile or viton may be used.
Inhalation/Suitable Respirator:	No respiratory protection should be needed.
Precautionary Measures:	Avoid eye contact at all times. Use reasonable care.

9. PHYSICAL AND CHEMICAL PROPERTIES

Pure Substance or Mixture:	Mixture	Solubility in Water:	Dispersible
Physical Form:	Liquid Emulsion	Viscosity @ 25 °C:	~ 2700 cP * (Pseudoplastic)
Color:	White	Bulk Density @ 25 °C:	8.35 lb/gal
Odor:	Bland	Evaporation Rate:	No Data
pH (neat @ 25 °C):	3.25 – 4.25	Vapor Pressure:	No Data
Oxidizing Properties:	Not Applicable	Vapor Density (Air = 1):	No Data
Boiling Point:	~ 212 °F	Volatile Organic %:	Negligible
Melting/Freezing Point:	~ 32 °F	Flash Point:	> 212 °F

The physical data presented here are approximations, as the actual product's values may vary slightly.
* Brookfield viscometer. Spindle #3; 6 rpm. Non-Newtonian viscosity. Viscosity will vary depending upon the sheer force applied. Increased sheer results in a lower viscosity.

Source: Trans-Chemco, Inc

10. STABILITY/REACTIVITY

Chemical Stability:	Stable under normal temperature and pressure.
Hazardous Polymerization:	Hazardous polymerization will not occur.
Materials to Avoid:	Strong oxidizing materials.
Conditions to Avoid:	See section 7.
Hazardous Decomposition Products:	Incomplete combustion may produce carbon monoxide and other asphyxiants.

	Health	Fire	Reactivity	Special
HMIS:	0	0	0	N/A
NFPA:	0	0	0	N/A

Note: HMIS and NFPA ratings involve data and interpretations that may vary from company to company. They are intended only for rapid, general identification of the magnitude of the specific hazard. To deal adequately with the safe handling of this material, all the information in this MSDS must be considered.

NFPA = National Fire Protection Association
HMIS = Hazardous Material Information System

11. TOXICOLOGICAL INFORMATION

Product Information: Unlikely to cause harmful effects under normal conditions of handling and use.

Route of Entry: Inhalation; Ingestion; Eye Contact

Chronic (Long-Term) Effects of Exposure:

Effects of Chronic Exposure:	Not Established
Target Organs:	Not Applicable
Carcinogen:	No

Special Hazard Information: No known applicable information.

12. ECOLOGICAL INFORMATION

Environmental Fate and Distribution

Complete information is not yet available.

Environmental Effects

Complete information is not yet available.

Fate and Effects in Waste Water Treatment Plants

Complete information is not yet available.

Hazard Parameters (LC50 or EC50)	High	Medium	Low
Acute Aquatic Toxicity (mg/L)	<= 1	> 1 and <= 100	> 100
Acute Terrestrial Toxicity	<= 100	> 100 and <= 2000	> 2000

*This table is adapted from "Environmental Toxicology and Risk Assessment," ASTM STP 1179, p.34, 1993
*This table can be used to classify the ecotoxicity of this product when ecotoxicity data is listed above. Please read the other information presented in the section concerning the overall ecological safety of this material.

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13. DISPOSAL CONSIDERATIONS

RCRA Hazard Class (40 CFR 261)

When a decision is made to discard this material, as received, it is classified as a hazardous waste? **No**
State or local laws may impose additional regulatory requirements regarding disposal.

EMPTY CONTAINER WARNINGS Empty containers may contain product residue. Follow MSDS and label warnings even after they have been emptied.

14. TRANSPORT INFORMATION

DOT Road Shipment Information (49 CFR 172.101)

DOT Proper Shipping Name:	N/A
DOT Technical Name:	N/A
DOT Primary Hazard Class:	N/A
DOT Secondary Hazard Class:	N/A
DOT Label Required:	N/A
DOT Placard Required:	N/A
DOT Poison Constituent:	N/A
Bill of Lading Description:	NOT REGULATED BY THE DEPARTMENT OF TRANSPORTATION
UN/NA CODE:	

Ocean Shipment (IMDG)

Not subject to IMDG code.

Air Shipment (IATA)

Not subject to IATA regulations
Call Trans-Chemco, Inc., (262) 857-2363, if additional information is required.

15. REGULATORY INFORMATION

Contents of this MSDS comply with OSHA Hazard Communication Standard 29 CFR 1910.1200.

TSCA Status: All chemical substances in this material are included on or exempted from listings on the TSCA Inventory of Chemical Substances.

EPA SARA Title III Chemical Listings
Section 302 Extremely Hazardous Substances: None
Section 304 CERCLA Hazardous Substances: None

CAS Number	Wt %	Component Name

Section 312 Hazard Class:

Acute:	No
Chronic:	No
Fire:	No
Pressure:	No
Reactive:	No

Section 313 Toxic Chemicals: None

Source: Trans-Chemco, Inc

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16. DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES

Disclaimer: This material safety data sheet (MSDS) was prepared in accordance with the 29 CFR 1910.1200. The information contained herein is based upon data available to us and reflects our best professional judgment. However, no warranty is expressed or implied regarding the accuracy of such information or the results obtained from the use thereof. We assume no legal responsibility whatsoever for any damage resulting from reliance upon this information since it is being furnished upon the condition that the person receiving it shall make his or her own determination of the suitability of the material described herein for a particular application, storage, or disposal situation.

Source: Trans-Chemco, Inc